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Remedial Response Section #2  
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Environmental

Subject:

Groundwater Evaluation and Work Plan for Supplemental Investigation  
Allied Paper, Inc./Kalamazoo River/Portage Creek Superfund Site  
Allied Paper, Inc. Operable Unit

Date:

April 28, 2009

Dear Mr. Berkoff:

Contact:

Tim Scully-Granzeier

Phone:

312.263.6703

Our ref:

B0064587.0001.00003

ARCADIS, on behalf of Millennium Holdings, LLC (MHLLC), has prepared this *Groundwater Evaluation and Work Plan for Supplemental Investigation* (Work Plan) at the request of the United States Environmental Protection Agency (USEPA). The primary goal of the supplemental work described in this Work Plan is to address concerns expressed by the City of Kalamazoo (the City) in their September 17, 2008 document *Interim Technical Responses to the Allied Paper Operable Unit Kalamazoo, Michigan Remedial Investigation Report* (City of Kalamazoo 2008a), particularly with regard to the potential for polychlorinated biphenyls (PCBs) present at the Allied Paper, Inc. Operable Unit (Allied OU) to migrate to the City's drinking water wells. In its document, the City stated that they did not believe this issue was adequately addressed in the Remedial Investigation (RI) Report for the Allied OU, which was finalized by the Michigan Department of Environmental Quality (MDEQ) in March 2008 (MDEQ 2008a). Based on the information available to date, including that presented in the RI Report, the weight-of-evidence does not indicate that a pathway for migration exists, as further supported herein; however, there is uncertainty with respect to potential impacts to the deeper regional aquifer beneath the Allied OU and regional groundwater flow conditions. MHLLC agrees to address these uncertainties prior to finalization of the Feasibility Study (FS) for the Allied OU.

ARCADIS developed this Work Plan and will carry out the activities proposed on behalf of MHLLC because there is agreement among all involved parties that the City's drinking water wells are a critically important public resource. It is also agreed that the potential for Allied OU-related constituents to migrate and impact the City's drinking water wells located

northwest of the Allied OU (City's Water Pumping Stations 1, 2, 3, and 7; hereafter referred to as the "Central Well Field") should be further assessed. Figure 1 shows the location of the City's well fields in relation to the Allied OU.

This Work Plan summarizes existing information that supported scope development and describes the recommended scope of work. Discussions held during two conference calls in March, and a meeting on April 14, 2009 of the involved parties, were influenced the proposed scope of work, which includes collection of an expanded set of groundwater and surface water level measurements, and an evaluation of the potential for lateral and downward migration of Allied OU-related constituents into the regional aquifer.

### **Purpose**

The purpose of the recommended investigation and evaluation is to reduce uncertainty associated with the potential for the Allied OU to impact the City's Central Well Field by further assessing the potential existence of a groundwater migration pathway from the Allied OU to the City wells.

The available data sources provide a foundation for understanding the subsurface at the Allied OU (through the RI Report [MDEQ 2008a]) and the regional hydrogeologic environment (through the City's groundwater flow model and capture zone analysis [City of Kalamazoo 1999], among other studies). The activities described in this Work Plan are designed to address the potential for the Allied OU to impact the City's Central Well Field through an evaluation of potential lateral groundwater flow in the shallow flow zone and potential vertical flow to the deeper regional groundwater flow zone.

ARCADIS evaluated various approaches and data needs relative to assessing the potential for a complete pathway for the migration of Allied OU-related constituents to the City's Central Well Field. Establishing an expanded hydrogeologic conceptual model, by providing additional measurement of hydraulic gradients in the vertical and horizontal directions, was selected as a direct method to assess whether the potential exists for Allied OU impacts to affect the City's Central Well Field. The primary hypotheses, which the investigation is designed to verify or disprove, are that shallow groundwater at the Allied OU discharges to Portage Creek, and that a hydraulic head differential across the low-permeability zone that underlies the Allied OU creates an upward vertical gradient that precludes downward flow from the Allied OU to the lower groundwater zone, which may be in communication with the City's Central Well Field. Therefore, synoptic measurement of water levels at strategic locations within and beyond the Allied OU constitutes the focus of this Work Plan. If the recommended hydrogeologic analysis demonstrates, by use of

hydraulic gradients in a weight-of-evidence approach, that the shallow groundwater from the Allied OU flows toward the creek and that there is an upward gradient across the aquitard, then it can be reasonably concluded that groundwater at the Allied OU could not impact the City's Central Well Field.

This analysis requires appropriate data collection locations between the Allied OU and the surrounding regional system. Vertically, the interface between the shallow groundwater flow zone at the Allied OU and the deeper regional aquifer tapped by the City's Central Well Field is defined by the low-permeability stratum (aquitard) that underlies the Allied OU and extends beyond the OU boundaries. Well pairs, with screens in both the surficial and regional units, will be monitored to evaluate the vertical gradient across the aquitard. Horizontally, the periphery of the Allied OU, specifically in the northwest direction, is proposed to be monitored to determine if there is the hydraulic potential for flow toward the City's Central Well Field in the shallow groundwater flow zone. In developing this plan, ARCADIS identified existing optimally-located well clusters at neighboring properties located adjacent to the OU in the direction of the City's Central Well Field. Potential monitoring points have been identified at the Strebor, Performance Paper, and Panelyte properties, as shown on Figure 2.

Other investigative methods were considered in developing this Work Plan, including sample collection and analysis for constituents of concern, geologic investigation to confirm the presence of the underlying low-permeability zone, evaluation of general groundwater chemistry at various points across the Allied OU, and use of pressure transducers to monitor water level changes. Each of these approaches may contribute to the understanding of the system; however, individually or collectively, these methods cannot positively conclude the presence/absence of a complete migration pathway. For example, a groundwater sample collected from below the low-permeability zone showing the presence of constituents that are also found on the Allied OU could originate from other sources given the history of industrial, manufacturing, and other activity in the surrounding areas, giving rise to questions of source attribution. If hydraulic gradients do not indicate the potential for migration, constituent sampling is unnecessary. Therefore, further assessment – specifically, measurement of groundwater levels and the evaluation of groundwater flow potential from the Allied OU, was selected as an appropriate approach to meet the objectives of the investigation/ evaluation. Similarly, the use of pressure transducers was considered to evaluate the dynamics and variability of water levels and gradients. In lieu of installing transducers in selected wells, the extensive history of water level gauging is available and will be evaluated to assess the temporal variability in flow patterns.

## Overview of Existing Information

Over the past 15 years, an extensive series of investigations has been completed at the Allied OU and a robust database has been developed. An overview of existing information that can be drawn on to understand the hydrogeologic environment and the potential for PCB transport in groundwater is presented below:

### Hydrogeologic Environment

The unconsolidated materials and groundwater investigated at the Allied OU are within the surficial aquifer (MDEQ 2008a), which is subdivided into several transmissive zones that are separated locally by discontinuous confining layers. The lowermost of the transmissive zones of the surficial aquifer is identified in the RI Report as the "Lower Sand." Upward hydraulic gradients relative to Portage Creek have been consistently observed at the OU, and shallow groundwater discharges to Portage Creek. Figure 3 (replicated from Figure 30 of the RI Report [MDEQ 2008a]) shows a flow-net constructed along cross-section B-B' (location shown on Figure 1), that passes through the OU. This flow-net indicates predominant lateral flow below the waste disposal areas of the OU. Approaching Portage Creek (located on both sides of the cross-section), the flow converges and discharges at Portage Creek.

Based on groundwater flow modeling completed by the City (City of Kalamazoo 1999), the surficial aquifer is separated hydraulically from the underlying regional aquifer by at least one laterally extensive confining unit. As shown on cross-section B" to B"' (Figure 4), an aquitard was encountered north of the Allied OU (2,200 feet north of the Allied OU disposal units), at an approximate elevation of 730 feet, and a sand/gravel and clay unit that may represent an extension of this unit was also encountered in the southernmost monitoring wells near the City's Central Well Field (81-10 and 81-11, located almost one mile north of the Allied OU disposal units). The aquitard was also encountered at the City's Millwood Well Field, located southeast of the Allied OU (Figure 1). While this aquitard was encountered below the depth of investigation at the Allied OU, it is believed to be locally continuous below the Allied OU based on supplemental sources (MDEQ 2008b, Bay West 1991). As the Kalamazoo River is approached (moving north from the Allied OU), the surficial aquifer and confining unit have been observed to be absent, and the regional aquifer becomes unconfined. This "pinching out" of the confining unit appears to occur well away from the Allied OU disposal areas, at least 2,200 feet, and likely more than 4,500 feet toward the Kalamazoo River. Regional data, including data from wells at nearby locations, indicate that there is an upward gradient from the regional aquifer to the surficial aquifer.

The above condition serves as a site model describing the assumed groundwater behavior relative to the Allied OU. This Work Plan is designed to verify pertinent elements of the site model.

In their September 17, 2008 comments on the RI Report (City of Kalamazoo 2008a), the City expressed a concern that one of the Allied OU well clusters that included a well screened in the Lower Sand member of the surficial aquifer (MW-122A and MW-122B) exhibited an apparent downward gradient. ARCADIS examined this issue and found that groundwater in the surficial aquifer near this well cluster appears to converge toward a transmissive zone located at an intermediate depth screened by nearby well MW-212. This means that when hydraulic head data from shallow well MW-122A, intermediate well MW-212, and deep (Lower Sand) well MW-122B are examined, MW-212 consistently exhibits the lowest hydraulic head; therefore, there is a downward gradient from MW-122A to MW-212 and an upward gradient from MW-122B to MW-212. Furthermore, the surface water elevation of Portage Creek is consistently lower than the water level in each of the wells, indicating flow into the creek. The data collection and evaluation associated with this Work Plan further address the vertical gradient at the Allied OU and the concern that groundwater from the surficial aquifer at the Allied OU may migrate into the regional aquifer unit. The specific conditions at MW-122A and MW-122B will be monitored and evaluated as part of this Work Plan. Additionally, water levels from other nested well pairs at the Allied OU will be evaluated to assess vertical gradients within the context of lateral flow and Portage Creek.

#### Potential PCB Transport

To address the specific concern regarding the potential migration of PCBs in groundwater, the available existing information suggests the potential for PCBs to impact the City's Central Well Field is low due to the following considerations.

- PCBs do not readily dissolve in water, preferring to adhere to soil or other solids (MDEQ 2008a, MDEQ, 2008b).
- Groundwater samples from the Allied OU generally do not contain actionable PCB concentrations; exceptions are a few instances where a well was screened in close proximity to a layer of PCB-containing paper-making residuals (residuals) (MDEQ 2008a).

- Water samples from the influent of the Allied OU leachate collection system generally do not contain detectable levels of PCBs, even though these samples are from water in direct contact with PCB-containing residuals.
- Although PCBs have been present at the Allied OU for more than 50 years, the City's monitoring results show that PCBs have not migrated to the City's Central Well Field. The City conducts routine monitoring, and has not detected PCBs in samples from its drinking water wells. Even in 2008, when more sensitive measurements were conducted, PCBs were not detected (City of Kalamazoo, 2008b).

In the 15 years of data collection efforts at the Allied Paper, Inc./Kalamazoo River/Portage Creek Superfund Site, the detection of PCBs in groundwater has generally been limited to areas within the landfill disposal units where groundwater is in contact with or in close proximity with PCB-containing materials. The infrequent detection of PCBs in groundwater and the general absence of PCBs in groundwater in wells away from areas with PCB-containing residuals are consistent with the physical/chemical properties of PCBs and equilibrium partitioning principles. PCBs preferentially exist in the sorbed, non-soluble phase and are essentially immobile in the dissolved phase, due to the effects of adsorption and retardation, combined with the high natural organic content of the matrix through which groundwater passes. As described in the April 30, 2008 MDEQ interoffice communication from Brant Fisher to Paul Bucholtz (MDEQ 2008b): "PCBs in groundwater is tempered in large part by the physiochemical properties of the compound that results in adsorption to solids, principally soil or sediment particles. As a result, the occurrence of PCBs in groundwater levels above the screening criteria is limited." Extensive response actions have been completed at the Allied OU since 1998, including soil and sediment removal, installation of a multi-layer cover system, and groundwater/leachate extraction and treatment. The treatment system was installed in 2000 and is operated continuously to treat water collected by the extraction wells along Portage Creek. No detections of PCBs above Groundwater Surface Water Interface Criteria of 0.2 micrograms per liter (set by the MDEQ, Remediation and Redevelopment Division (RRD) Operational Memorandum No. 5, September 30, 2004) have been reported in the influent or the effluent of the treatment system since it was installed.

Information contained in both the 2008 MDEQ RI Report and the communication from Brant Fisher suggests that there is not a pathway for PCBs in the Allied OU to the City's Central Well Field. In the RI Report, MDEQ concluded that the vertical groundwater gradients between the shallow transmissive zones are upward at the Allied OU (preventing contamination of deeper aquifer zones that may be in connection with the

City's Central Well Field), and the discharge point for groundwater is Portage Creek (so shallower groundwater flow is to the creek and not downward or off of the property).

Further, Mr. Fisher states that, "It is the opinion of the SWPU [Surface Water Protection Unit] that there is little likelihood of an impact to the public water supply wells in question." Mr. Fisher also discusses the regional hydrogeology and describes a conceptual model for the Allied OU and surrounding area. He confirms limited instances of PCBs in groundwater, despite PCBs in soils at the Allied OU, and states that groundwater flow patterns presented in the March 2008 RI Report (and depicted in Figure 3, replicated from Figure 30 of the RI report [MDEQ 2008a]) showing that the discharge point for the groundwater investigated at the Allied OU is Portage Creek "appear reasonable." Mr. Fisher also notes that "heads in the regional flow system<sup>1</sup> are generally higher than those in the surficial aquifer system, which one can assume precludes, to some degree, the downward migration of contaminants." Mr. Fisher does recommend that because a downward migration pathway cannot be "totally ruled out," additional data should be collected to better define environmental conditions at the Allied OU and further investigate the possibility of a migration pathway from the Allied OU to the Central Well Field. Specifically, Mr. Fisher recommends as part of the FS process installation of wells located between Allied OU and the Central Well Field.

### **Review of Additional Information**

The following additional information is summarized to provide the basis for the scope of work presented in this letter.

#### City of Kalamazoo Drinking Water Production Well Data

The City has periodically analyzed samples of water produced by its Central Well Field for PCBs, among other contaminants. Although PCB-containing residuals have existed at the Allied OU for over 50 years as a potential source of PCBs to groundwater, PCBs have never been detected in the Central Well Field, based on the data made available to ARCADIS. Even during a 2008 sampling event, in which 11 samples of City water were collected and analyzed for PCBs and other chemicals using an analytical procedure with

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<sup>1</sup> The City's Central Well Field is inferred to tap this regional flow system, which is interpreted by Mr. Fisher to underlie the surficial aquifer system that was investigated at the Allied OU. Near the City's Central Well Field and the Allied OU, the two aquifer systems are interpreted to be separated by a confining unit, which would limit and restrict movement of groundwater between the two aquifers.

the ability to detect PCBs at a lower concentration than used in previous testing<sup>2</sup>, PCBs were not detected in any samples (City of Kalamazoo, 2008b). This is direct evidence that PCBs are not reaching the Central Well Field from the Allied OU even though they have been in the environment and used in municipal and industrial applications associated with numerous activities in Kalamazoo, in addition to paper recycling, for over 50 years.

#### Strebor Property Hydrogeologic Investigation Results

The Strebor property, located immediately west of the Allied OU, was the subject of a Remedial Investigation completed in 1991, although PCBs were not a primary constituent of concern. The Remedial Investigation/ Feasibility Study Work Plan (Bay West 1990), the Remedial Investigation/ Feasibility Study for Strebor Inc, (Bay West 1991), and the Draft Remedial Action Plan for Strebor, Inc (Bay West 1993) were obtained and reviewed by ARCADIS. These documents show an unconfined surficial aquifer that is approximately 50 to 70 feet thick, underlain by a silty clay confining unit that is approximately 8 to 10 feet thick. Beneath the confining unit is a well sorted, medium to coarse grained sand and gravel unit (interpreted by Bay West to be part of the regional flow system) that is under confined conditions (i.e., the head in the well is higher than the base of the confining unit), and in one instance flowing artesian conditions (i.e., the head in the well is higher than ground surface). The general agreement among the Strebor cross-sections, the Allied RI Report, and the hydrogeologic assessment presented in the communication from Brant Fisher provides support for the conclusions of the Allied RI Report (MDEQ 2008a).

The locations of three pairs of monitoring wells (MW-36 and 37; MW-38 and 39; and MW-30 and 40) consisting of one well screened in the surficial aquifer system and one well screened in the regional flow system installed on and adjacent to the Strebor property are shown on Figure 2. One of the well pairs is located on the former Strebor property, one well pair is located adjacent to the northern portion of the Allied OU, and the third well pair is located north of Alcott Street and west of Portage Creek on the former Performance Paper Mill property. Evaluation of water levels in the well pairs indicates an upward hydraulic potential (potential difference of up to 10 feet). Water levels were measured in these three well pairs on several occasions and each data set shows a consistent upward gradient. This information is compatible with data presented in the RI Report for the Allied OU (MDEQ 2008a), as well as the Fisher memo (MDEQ, 2008b).

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<sup>2</sup> This method was capable of detecting individual PCB Aroclor concentrations as low as 0.050 µg/L (50 parts per trillion).



#### Hydrogeologic Investigation at Additional Neighboring Sites

During preparation of this Work Plan, efforts have been made to locate additional monitoring wells installed north of the Allied OU that could potentially be used as groundwater elevation monitoring points and provide additional information regarding the groundwater flow pathways in the area. As a result, it was found that subsurface investigations have been completed at the Panelyte and Performance Paper properties, both located adjacent to the Allied OU, as shown on Figure 1. The locations of the wells that were installed at the two properties are shown on Figure 2. To date, ARCADIS has not received boring and well installation logs for these wells, or been able to verify their current condition. However, as part of the scope of work described below, well information will be pursued for these properties, and it is anticipated that a subset of the existing wells will be used to provide additional groundwater elevation measurements.

#### Groundwater Flow Model and Capture Zone Delineation for City's Central Well Field

The Water Pumping Stations 1, 2, 3, 4, & 7, Groundwater Flow Model and Capture Zone Delineations report developed by the City of Kalamazoo and Peerless-Midwest Company, Inc. (City of Kalamazoo 1999) provides relevant information regarding the geology and groundwater movement in the area between the Central Well Field and the Allied OU.

The report states that the City's production wells are screened in the regional aquifer, and the flow model indicates that the Allied OU resides within the 5-year time-of-travel capture zone of the Central Well Field. ARCADIS reviewed the flow model assumptions, analysis, and conclusions and identified uncertainties, including: consistency with data collected from the Allied OU, an apparent under-estimation of hydraulic conductivity, the simulation of Portage Creek, and the model grid size near the Allied OU. Given these uncertainties, it is possible that groundwater in the regional aquifer below the Allied OU is not captured by the Central Well Field and, instead, discharges to the Kalamazoo River, which is a "gaining stream," in the same manner the surficial aquifer discharges to Portage Creek. However, for the purpose of designing this Work Plan, ARCADIS will conservatively assume that groundwater in the regional aquifer is captured in the Central Well Field. Given this assumption and the fact that the objective of this investigation/ evaluation is independent of the time-of-travel assessment, the uncertainties are not directly relevant to the scope of this Work Plan.

## Scope of Work

The following Tasks 1 and 2 will be completed in accordance with the standard field procedures and project-specific health and safety procedures:

Task 1 – Well Identification and Evaluation: The three pairs of nested wells identified at the Strebtor property (MW-36 and 37; MW-38 and 39; and MW-30 and 40) will be used to evaluate the vertical gradient across the confining unit that underlies the surficial aquifer. The well pairs are located in a non-colinear arrangement between the Allied OU disposal areas and the Central Well Field, with the deeper well screened in the regional aquifer unit and the shallower well screened in the surficial aquifer unit. Spatially, these wells are appropriately located at the northwest periphery between the Allied OU disposal areas and the Central Well Field (Figure 1). Vertically, they are appropriately screened to evaluate the hydrogeologic relationship between the regional and surficial aquifer units. If further inspection indicates these existing wells are not in suitable condition to meet the investigation objectives, or if access to these wells cannot be readily obtained, then MHLLC will work with USEPA, MDEQ, and the City of Kalamazoo to consider other wells in the area and/or new wells. In addition to these three well pairs, additional shallow wells at the Strebtor property, and potentially additional wells located at the Performance Paper and Panelyte properties will be available to provide subsurface information.

Task 2 – Water Level Measurements: To observe (1) the gradient between the regional aquifer and the surficial aquifer, and (2) the gradient within the surficial aquifer relative to water levels in Portage Creek, water level data/ potentiometric surface data will be collected in one synoptic round from:

- Seventy-nine monitoring wells located at the Allied OU, as listed in Table 1 and shown on Figure 2 (pending field verification of acceptable well condition)
- Thirteen monitoring wells located at the Strebtor property, including monitoring well pairs MW-36 and 37; MW-38 and 39; and MW-30 and 40 (if suitable and accessible), as listed in Table 2 and shown on Figure 2
- Additional wells located at the Panelyte and Performance Paper properties, pending verification of construction details, condition, and access (potential monitoring locations shown on Figure 2)
- Allied OU stream gauges SG-1 and SG-2 (existing)

- Stream gauge at the upstream side of the Alcott Street Dam
- Two new stream gauges to be installed along Portage Creek, north of the Allied OU at the approximate locations shown on Figure 2
- Standing water in the low-lying area in the Western Disposal Area, and other onsite areas of standing water

Prior to starting work, ARCADIS will obtain agreements for access to the existing offsite wells and will verify that all wells to be gauged and sampled are accessible and in acceptable condition. ARCADIS will request USEPA's assistance in obtaining access if necessary. The offsite measuring points will be surveyed and several measuring points at the Allied OU will be re-surveyed to verify a consistent survey datum between all of the measured points.

**Task 3 – Desktop Review:** An updated literature review will be completed to evaluate available regional hydrogeologic data. This will include integrating newly collected data and information from the City's flow model to better understand the relationships between the Allied OU and the regional system. This task will also explore flow patterns beyond the influence of the Central Well Field as they may pertain to the Allied OU.

**Task 4 - Evaluation and Reporting:** The evaluation task will involve integrating the historic and newly-acquired information into a cohesive groundwater Conceptual Site Model that addresses both the transport mechanisms governing groundwater flow and other processes affecting the fate of PCBs in the environment. Upon review of the water level measurements and the supplemental data evaluation, conclusions regarding the presence or absence of a groundwater pathway from the Allied OU to the Central Well Field will be revisited. The report will provide a thorough description of the assessment, with tabular and graphical presentation to clearly communicate the findings.

If USEPA determines that the results confirm prior conclusions, MHLLC will use the existing hydrogeologic assumptions presented in the March 2008 RI Report in the FS. If USEPA determines the supplemental investigation/ evaluation results do not corroborate the general hydrogeologic assumptions for the Allied OU and that available information does not support development of a conceptual site model that is adequately complete and refined, then MHLLC will work with USEPA and MDEQ to further evaluate the observed conditions and address groundwater as a potential

migration pathway. MHLLC understands that if the current hydrogeologic assumptions are not supported and there is a need to modify the conceptual model of potential migration, further investigation may be necessary.


Following data collection and evaluation, ARCADIS will prepare and submit a letter report summarizing the results of the activities described in this Work Plan.

### Closing

If you have any questions or comments regarding this Work Plan, please contact the undersigned.

Respectfully Submitted,

ARCADIS

  
Lisa Coffey  
Project Hydrogeologist

  
Tim Scully-Granzeier  
Project Manager

### Enclosures :

- Table 1 – Proposed Groundwater Elevation Monitoring Locations – Allied OU
- Table 2 – Proposed Groundwater Elevation Monitoring Locations – Strebor Property
- Figure 1 – Cross-Section Location Map
- Figure 2 – Allied OU Groundwater Elevation Monitoring Locations
- Figure 3 – Geologic Cross Section B-B' Groundwater Flow Net, June 19, 2003
- Figure 4 – Geologic Cross Section B''-B'-B'''

### Copies:

James Saric, USEPA  
Paul Bucholtz, MDEQ  
Jeff Keiser, CH2MHILL

Steve Weishar, MHLLC  
Michael J. Erickson, P.E., ARCADIS

## References

Bay West. 1990. *Remedial Investigation/Feasibility Study Work Plan*. June 1990.

Bay West. 1991. *Remedial Investigation/ Feasibility Study* for Strebor Inc. July 1991.

Bay West. 1993. *Draft Remedial Action Plan* for Strebor, Inc. October 1993.

City of Kalamazoo. 2008a. *Interim Technical Responses to the Allied Paper Operable Unit Kalamazoo, Michigan Remedial Investigation Report*. September 17, 2008.

City of Kalamazoo 2008b. Data transmittal via e-mail from Bruce Merchant (City of Kalamazoo) to Michael Berkoff (USEPA) and Suda Arakere (MHLLC). September 29, 2008.

City of Kalamazoo. 1999. *The Water Pumping Stations 1, 2, 3, 4, & 7, Groundwater Flow Model and Capture Zone Delineations Report*. November, 1999.

MDEQ. 2004. RRD Operational Memorandum No. 5. September 30, 2004.

MDEQ. 2008a. *Remedial Investigation Report for the Allied Paper, Inc. Operable Unit*. March 2008.

MDEQ. 2008b. MDEQ interoffice communication from Brant Fisher to Paul Bucholtz. April 30, 2008.

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Tables

**Allied Paper, Inc./Portage Creek/Kalamazoo River/Superfund Site  
Groundwater Evaluation and Work Plan for Supplemental Investigation**

**Table 1 -- Proposed Groundwater Elevation Monitoring Locations - Allied OU**

Well/Piezometer	Date Installed	Total Depth (feet)	Ground Surface Elevation (feet)	Elevation of Bottom of Screen (feet)	Elevation of Top of Screen (feet)	Elevation of Top of Sand (feet)	Elevation of Top of Bentonite (feet)	Hydrostratigraphic Unit Screened Within Shallow Zone (Units as Defined in RI)
FW-101	6/10/2002	5.0	797.3	793.1	795.3	796.3	797.3	Upper Sand
GWE-1/GWE-1P	2/10/2000	41.0	802.7	782.0	791.8	794.8	796.8	Upper Sand/Peat/Upper Aquitard
GWE-1A	5/4/2000	35.0	806.6	776.8	791.7	792.8	795.6	Upper Sand/Upper Aquitard
GWE-4A	6/20/2000	42.5	805.7	771.3	781.2	784.2	801.7	Upper Sand
MW-120A	7/28/1993	23.8	819.6	796.1	801.1	801.4	804.6	Residuals/Upper Sand
MW-120B	7/27/1993	30.5	819.4	788.9	793.9	793.9	796.9	Upper Sand
MW-122A	8/6/1993	21.5	803.4	781.9	791.9	794.0	797.4	Upper Sand/Peat
MW-122AR	3/31/1998	19.3	804.0	784.7	794.7	795.9	800.0	Upper Sand/Peat
MW-122B	8/4/1993	60.5	803.6	743.3	748.3	750.4	753.6	Lower Sand
MW-124A	8/23/1993	36.0	841.3	805.3	815.3	817.3	820.3	Upper Sand
MW-124B	8/19/1993	59.0	842.1	783.1	788.1	790.1	793.6	Upper Sand
MW-125A	8/22/1993	25.0	807.7	783.2	788.2	788.3	791.3	Upper Sand/Peat
MW-126A	7/21/1993	20.5	802.8	782.3	787.3	787.3	790.3	Upper Sand
MW-126AR	4/1/1998	21.5	803.6	782.1	787.1	787.8	790.6	Upper Sand
MW-16B	6/13/1988	33.0	801.9	768.9	771.9	773.9	800.9	Intermediate Sand
MW-19BR	8/20/1993	39.4	819.5	780.5	785.5	787.5	790.3	Upper Aquitard <sup>4</sup>
MW-200A	10/4/2000	15.8	800.9	785.1	790.1	791.9	793.9	Sand <sup>3</sup>
MW-201B	10/5/2000	29.0	800.3	772.3	777.3	779.3	783.3	Sand <sup>3</sup>
MW-202B	9/24/2000	35.0	801.1	767.9	772.6	774.6	778.1	Sand <sup>3</sup>
MW-203B	9/23/2000	24.0	798.3	774.7	779.4	781.0	792.3	Sand <sup>3</sup>
MW-204B	10/9/2000	65.0	800.6	736.6	741.6	743.6	745.6	Lower Sand
MW-205B	10/11/2000	26.0	799.5	774.5	779.5	781.5	788.5	Lower Sand
MW-206A	6/10/2002	14.0	797.7	785.7	790.7	791.2	795.7	Sand <sup>3</sup>
MW-207	5/31/2002	34.0	797.9	765.3	769.9	771.9	774.9	Intermediate/Lower Sand <sup>2</sup>
MW-208	5/30/2002	24.0	796.3	773.3	778.3	780.3	783.8	Intermediate/Lower Sand <sup>2</sup>
MW-209	6/17/2002	34.0	787.0	754.0	759.0	761.0	764.0	Intermediate Sand
MW-210	6/5/2002	18.1	797.0	779.0	784.0	785.0	789.0	Sand <sup>3</sup>
MW-211	6/17/2002	30.0	788.1	759.9	764.6	766.6	769.6	Intermediate Sand
MW-212	6/18/2002	18.0	786.8	769.9	774.6	776.8	780.8	Intermediate Sand

See Notes on Page 3.

**Allied Paper, Inc./Portage Creek/Kalamazoo River/Superfund Site  
Groundwater Evaluation and Work Plan for Supplemental Investigation**

**Table 1 -- Proposed Groundwater Elevation Monitoring Locations - Allied OU**

Well/Piezometer	Date Installed	Total Depth (feet)	Ground Surface Elevation (feet)	Elevation of Bottom of Screen (feet)	Elevation of Top of Screen (feet)	Elevation of Top of Sand (feet)	Elevation of Top of Bentonite (feet)	Hydrostratigraphic Unit Screened Within Shallow Zone (Units as Defined in RI)
MW-213	7/3/2002	22.0	787.4	766.8	771.4	773.4	776.4	Intermediate Sand
MW-214	7/8/2002	32.0	794.2	764.6	769.2	770.2	772.3	Upper Aquitard/Intermediate Sand
MW-215	3/31/2003	8.0	783.6	777.8	782.6	783.1	784.6	Upper Sand
MW-216	3/28/2003	10.0	783.6	774.2	779.0	779.5	781.6	Upper Sand
MW-217	3/28/2003	12.0	783.2	774.7	776.7	777.2	780.2	Peat/Upper Sand
MW-218	3/28/2003	12.0	783.5	771.7	776.5	777.0	780.5	Upper Sand
MW-219	3/28/2003	14.0	788.9	775.6	780.4	780.9	784.9	Upper Sand
MW-220	3/31/2003	6.0	785.9	780.1	784.9	785.4	786.9	Upper Sand
MW-221R	4/8/2003	10.0	785.9	778.0	779.9	780.4	783.9	Upper Sand
MW-222	4/3/2003	12.0	792.8	783.2	787.8	788.3	791.8	Peat/Upper Sand
MW-223	4/3/2003	10.0	794.3	785.3	788.2	793.6	795.3	Upper Sand
MW-224	3/12/2003	26.0	810.3	786.7	791.3	793.3	796.7	Upper Sand
MW-225	3/7/2003	10.0	789.4	780.3	784.9	785.4	787.9	Upper Sand
MW-226	3/3/2003	2.0	783.8	781.8	783.8	783.9	784.8	Upper Sand
MW-227	3/28/2003	2.0	782.1	780.1	782.1	782.2	783.1	Upper Sand
MW-228	3/28/2003	4.0	783.4	780.4	783.4	783.5	784.4	Upper Sand
MW-229	3/28/2003	6.0	784.3	780.3	784.3	784.4	785.3	Upper Sand
MW-22AR	4/1/1998	17.0	807.5	791.0	796.0	796.5	798.5	Upper Sand/Peat
MW-22B	8/11/1993	48.0	804.6	757.6	762.6	764.6	767.6	Intermediate/Lower Sand <sup>2</sup>
MW-230	4/3/2003	6.0	785.9	781.9	785.9	786.0	786.9	Upper Sand
MW-231	3/31/2003	22.0	785.9	764.1	768.9	770.1	772.6	Intermediate Sand
MW-232	3/31/2003	14.0	785.3	773.3	776.3	777.0	781.3	Upper Sand
MW-23R	10/19/2000	84.0	804.0	720.0	725.0	730.4	789.0	Sand <sup>3</sup>
MW-24R	3/27/1998	24.0	806.6	782.6	787.6	788.6	791.1	Upper Sand/Upper Aquitard
MW-26	8/25/1989	9.0	790.0	781.0	784.0	-	789.0	Upper Sand
MW-5R	3/26/1998	26.5	810.1	783.6	789.6	789.6	792.1	Peat/Upper Sand
MW-6	11/16/1985	25.0	810.7	785.7	788.7	790.7	809.7	Upper Sand
MW-7	11/16/1985	31.0	817.4	786.4	789.4	791.4	816.4	Upper Sand
MW-8A	8/10/1993	18.0	809.0	791.0	796.0	796.0	799.0	Peat/Upper Sand/Upper Aquitard

See Notes on Page 3.



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**Table 1 -- Proposed Groundwater Elevation Monitoring Locations - Allied OU**

Well/Piezometer	Date Installed	Total Depth (feet)	Ground Surface Elevation (feet)	Elevation of Bottom of Screen (feet)	Elevation of Top of Screen (feet)	Elevation of Top of Sand (feet)	Elevation of Top of Bentonite (feet)	Hydrostratigraphic Unit Screened Within Shallow Zone (Units as Defined in RI)
OW-11A	10/7/2000	19.9	799.4	781.2	785.9	787.9	789.9	Upper Sand
OW-12A	9/1/2000	24.4	803.9	779.7	784.4	785.9	802.9 <sup>1</sup>	Upper Sand
OW-13A	10/3/2000	14.8	798.0	783.4	786.2	787.0	788.5	Upper Sand
OW-14P	5/31/2002	8.0	795.8	788.0	792.8	793.3	795.8	Upper Sand/Upper Aquitard
OW-15P	6/26/2002	18.0	809.3	792.7	797.6	799.6	802.1	Upper Sand
OW-16P	6/26/2002	8.0	797.7	790.7	795.6	796.7	797.7	Upper Sand
OW-17P	6/26/2002	8.0	794.0	787.6	792.5	793.0	794.0	Upper Sand
OW-1A	2/17/2000	22.0	806.7	786.3	788.3	788.8	792.2	Upper Sand
OW-1P	2/21/2000	14.9	803.6	788.8	797.8	798.6	801.6	Upper Sand
OW-2A	2/22/2000	18.5	804.6	786.2	788.1	788.5	791.6	Upper Sand/Upper Aquitard
OW-2B	2/21/2000	34.4	804.4	770.4	775.2	776.9	780.2	Intermediate Sand/Lower Aquitard
OW-2P	2/22/2000	15.5	804.7	789.3	794.1	795.2	797.9	Upper Sand
OW-3AR	9/28/2000	16.0	799.1	784.1	788.7	790.1	792.1	Upper Sand
OW-3PR	9/28/2000	9.5	798.9	790.9	795.7	796.6	797.9	Upper Sand/Peat
OW-4AR	9/27/2000	25.0	804.2	779.2	783.8	785.2	786.7	Sand <sup>3</sup>
OW-4PR	6/25/2002	9.0	801.4	793.0	800.5	800.5	801.4	Upper Sand
OW-5P	3/2/2000	24.0	817.4	796.1	800.9	802.8	805.4	Upper Sand
OW-6A	3/3/2000	50.0	818.2	786.3	791.1	792.4	794.7	Sand <sup>3</sup>
OW-6P	3/7/2000	21.5	818.2	796.8	801.6	803.8	805.9	Residuals/Upper Sand
OW-7PR	6/14/2000	18.5	805.9	789.4	794.2	794.9	796.9	Upper Sand
OW-9PR	9/26/2000	10.0	801.1	791.1	796.1	798.1	799.6	Upper Sand/Peat

**Notes:**

<sup>1</sup> Depth to top of grout, bentonite not present.

<sup>2</sup> The hydrostratigraphic unit screened is identified as intermediate/lower sand; however, borings in this area of the Allied OU have not extended to a sufficient depth to locate the lower aquitard.

<sup>3</sup> Intervening clay layers are absent beneath the peat in this area of the Allied OU; therefore, the upper, intermediate and lower sand units can be thought of as one hydrostratigraphic unit within the surficial unit.

<sup>4</sup> Screens a sand seam within the upper aquitard.

RI = Remedial Investigation.

**Allied Paper, Inc./Portage Creek/Kalamazoo River/Superfund Site  
Groundwater Evaluation and Work Plan for Supplemental Investigation**

**Table 2 -- Proposed Groundwater Elevation Monitoring Locations - Strebor Property**

Well Number	Aquifer Unit	Well Depth (feet bg)	Top of Casing Elevation (feet MSL)	Grade Elevation (feet MSL)	Well Diameter (inches)	Screened Interval (feet bg)	Top of Screen (feet MSL)	Bottom of Screen (feet MSL)
MW-1	Shallow	16.0	803.2	801.6	2	11.0 -16.0	790.6	785.6
MW-7	Shallow	12.0	795.58	793.5	2	7.0-12.0	786.5	781.5
MW-15	Shallow	10.5	797.58	796.4	2	5.5-10.5	790.9	785.9
MW-21	Shallow	10.0	795.01	793.0	2	5.0-10.0	788.0	783.0
MW-24	Shallow	13.2	800.26	797.8	2	5.3-13.1	792.5	784.7
MW-25	Intermediate	27.1	795.31	793.1	2	22.3-27.1	770.8	766.0
MW-30	Shallow	14.7	796.35	793.8	2	9.7-14.7	784.1	779.1
MW-35	Intermediate	20.3	795.83	793.0	2	15.3 - 20.3	777.7	772.7
MW-36	Shallow	12.0	789.92	786.6	2	2.0-12.0	784.6	774.6
MW-37	Deep	87.0	789.18	786.6	2	82.0-87.0	704.6	699.6
MW-38	Shallow	12.2	782.17	779.6	2	2.2-12.2	777.4	767.4
MW-39	Deep	85.5	782.18	779.2	2	80.5-85.5	698.7	693.7
MW-40	Deep	92.0	797.16	794.8	2	87.0-92.0	707.8	702.8

**Notes:**

bg = below ground.

MSL = mean sea level.

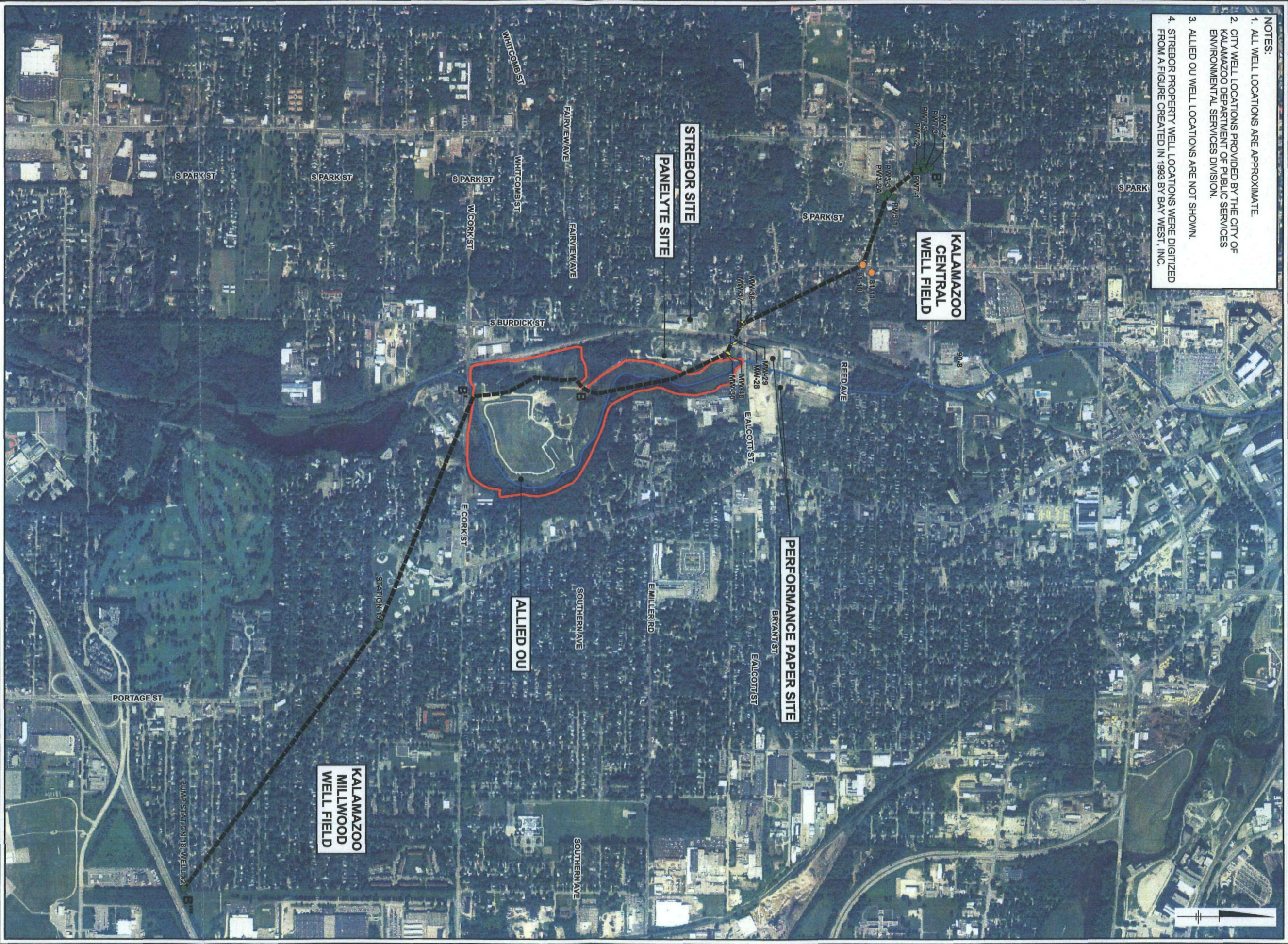
Well construction information from the Remedial Investigation and Feasibility Study for Strebor Inc., Kalamazoo, Inc., by Bay West, Inc., dated 7/24/1991.

ARCADIS

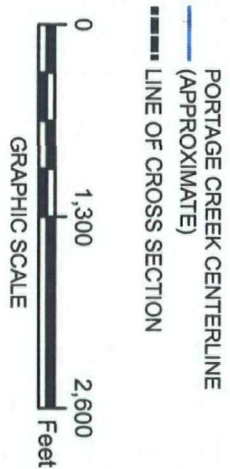
**Figures**



- NOTES:
1. ALL WELL LOCATIONS ARE APPROXIMATE.
  2. CITY WELL LOCATIONS PROVIDED BY THE CITY OF KALAMAZOO DEPARTMENT OF PUBLIC SERVICES ENVIRONMENTAL SERVICES DIVISION.
  3. ALLIED OU WELL LOCATIONS ARE NOT SHOWN.
  4. STREBOR PROPERTY WELL LOCATIONS WERE DIGITIZED FROM A FIGURE CREATED IN 1993 BY BAY WEST, INC.



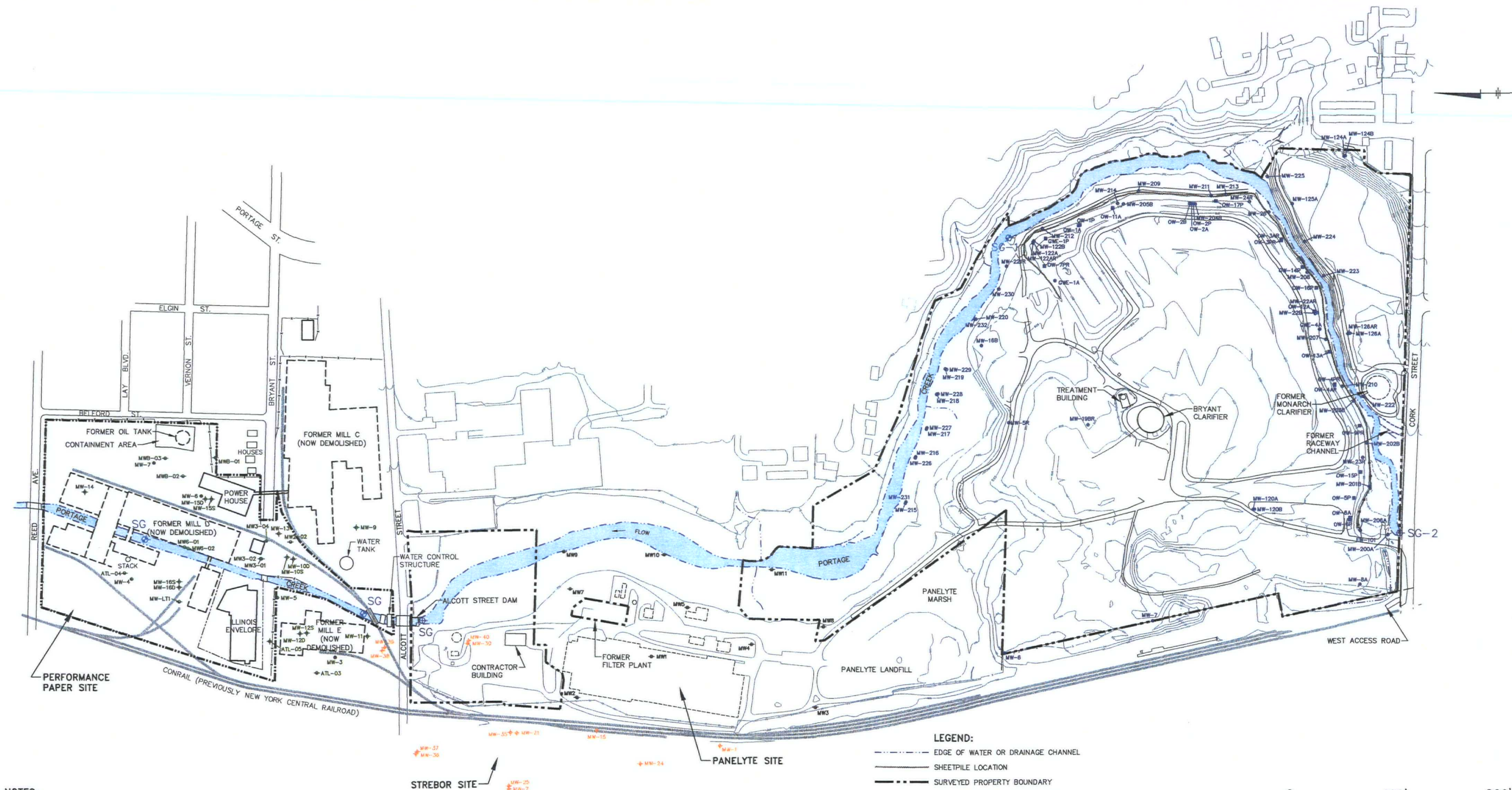
- LEGEND:
- CITY MONITORING WELL
  - CITY PRODUCTION WELL
  - ▲ STREBOR PROPERTY WATER TABLE MONITORING WELL
  - ▲ STREBOR PROPERTY INTERMEDIATE MONITORING WELL
  - ▲ STREBOR PROPERTY DEEP MONITORING WELL
  - ALLIED PAPER, INC. OPERABLE UNIT BOUNDARY (APPROXIMATE)



KALAMAZOO RIVER STUDY GROUP  
ALLIED PAPER, INC./PORTAGE CREEK/  
KALAMAZOO RIVER SUPERFUND SITE  
ALLIED PAPER, INC. OU

CROSS-SECTION LOCATION MAP





NOTES:

1. TOPOGRAPHIC MAPPING NORTH OF FORMER TYPE III LANDFILL AREA, AND BRYANT HRDLs/FRDLs PRODUCED USING PHOTOGRAMETRIC METHODS BY LOCKWOOD, INC. FROM AERIAL PHOTOGRAPHY FLOWN MAY 1991. BASE MAP INFORMATION WITHIN FORMER TYPE III LANDFILL AREA AND AREA NORTH OF WESTERN DISPOSAL AREA FIELD SURVEY OBTAINED FROM PLAN ENTITLED "TOPOGRAPHIC AND BOUNDARY SURVEY OF ALLIED PAPER, INC. KALAMAZOO, MI. SECTION 27, TOWN 2 SOUTH, RANGE 11 WEST," PREPARED BY WADE-TRIM, INC., DATED 7/8/99. BASE MAP INFORMATION WITHIN BRYANT HRDLs/FRDLs AREA OBTAINED FROM PLAN ENTITLED "AS BUILT SURVEY OF ALLIED PAPER SITE" PREPARED BY PREIN AND NEWHOF, KALAMAZOO, MI. DATED 1/27/05 (PROJECT NO. 2000171K). TOPOGRAPHIC CONTOUR LINES INSIDE THE MONARCH HRDL AREA SURVEYED BY PREIN & NEWHOF SURVEYORS ON 4/03. NGVD 1929. BASE MAP INFORMATION IN THE WESTERN DISPOSAL AREA BASED ON TOPOGRAPHIC SURVEY PERFORMED BY PREIN & NEWHOF, DRAWING FILE NUMBER 2060643K, DATED SEPTEMBER 27, 2006. BASE MAP INFORMATION AND PERFORMANCE PAPER WELL LOCATIONS BY MACTEC (2002), AND ATLANTIC TESTING (1990) NORTH OF ALCOTT STREET PREPARED BY DIGITIZING A PAPER COPY OF A PDF OF A DRAWING MADE BY "FISHBECK, THOMPSON, CARR & HUBER ENGINEERS-SCIENTISTS-ARCHITECTS" TITLED BASELINE ENVIRONMENTAL ASSESSMENT-SITE PLAN PROJECT NUMBER G03561A, DATED 2005, AT A SCALE OF 1"=150'. PERFORMANCE PAPER WELL LOCATIONS BY "ENVIRONMENTAL CONSULTING & TECHNOLOGY, INC." (ECT), DIGITIZED FROM PAPER COPY OF A PDF OF A DRAWING MADE BY "ECT" TITLED "SITE MAP WITH SAMPLING LOCATIONS - FIGURE 4", DATED 2005, AT A SCALE OF 1"=200'.
2. ELEVATIONS ARE REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) 1929.
3. COORDINATE GRID IS REFERENCED TO THE MICHIGAN STATE PLANE (SOUTH ZONE) COORDINATE SYSTEM (NAD83).
4. ALLIED PROPERTY LINES ESTABLISHED USING: WADE-TRIM SURVEY (9/1999)-NORTHERN PARCEL ONLY; ATWELL HICKS, INC. SURVEY (11/2002); AND PREIN AND NEWHOF SURVEY (12/2002).
5. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C:/PROJ/28963/\_GIS/001/001\_REPORT.APR REVISED 11/10/02. PORTAGE CREEK OUTLINE NORTH OF THE ALLIED PROPERTY UPDATED ON 12/4/02 USING A CDM CREEK OUTLINE PREPARED ON 9/23/02 PROVIDED ON COMPACT DISK.
6. PANELYTE WELLS ARE APPROXIMATE.
7. ALL KNOWN PERFORMANCE PAPER AND PANELYTE WELLS ARE SHOWN; HOWEVER, ONLY SELECT WELLS WILL BE GAUGED, DEPENDING ON REVIEW OF WELL CONSTRUCTION DETAILS, VERIFICATION OF SATISFACTORY WELL CONDITION, AND THE DISTRIBUTION OF AVAILABLE MONITORING POINTS.

- LEGEND:
- EDGE OF WATER OR DRAINAGE CHANNEL
  - SHEETPILE LOCATION
  - SURVEYED PROPERTY BOUNDARY
  - APPROXIMATE PROPERTY BOUNDARY
  - TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
  - RAILROAD TRACK
  - ROAD/TRAIL
- ALLIED OU
- MW-26 SINGLE-CASED MONITORING WELL OR CLUSTER
  - MW-203B DOUBLE-CASED MONITORING WELL
  - OW-12A PIEZOMETER LOCATION
  - OWE-1A RECOVERY WELL LOCATION
- PANELYTE
- MW1 MONITORING WELL INSTALLED BY PANELYTE
- STREBOR
- MW-1 STREBOR WELL LOCATION
- PERFORMANCE PAPER
- MW-120 MONITORING WELL (ECT-2005)
  - ATL-03 MONITORING WELL (MACTEC-2002)
  - MW-3 MONITORING WELL (ATLANTIC TESTING-1990)
- SG-2 EXISTING SURFACE WATER STAFF GAUGE
- SG PROPOSED SURFACE WATER STAFF GAUGE

KALAMAZOO RIVER STUDY GROUP  
ALLIED PAPER, INC. / PORTAGE CREEK /  
KALAMAZOO RIVER SUPERFUND SITE  
ALLIED PAPER, INC. OU

**ALLIED OU GROUNDWATER ELEVATION  
MONITORING LOCATIONS**


 **ARCADIS**

FIGURE  
**2**



